Lesson Plan Title
Movement Batteries

Grade Level
4th Grade

Subject Area
Science

MSCCRS
P.4.6A.3 - Develop models demonstrating how heat and electrical energy can be transformed into other forms of energy (e.g., motion, sound, heat, or light).

P.4.6A.4 - Develop models that demonstrate the path of an electric current in a complete, simple circuit (e.g., lighting a light bulb or making a sound).

Conceptual Understanding:
As different forms of energy, heat, and electricity can be produced in different ways and are transferred and conducted from one form or object to another. Some materials can be conductors or insulators of heat energy. Electricity can be transferred from place to place by electric currents to produce motion, sound, heat, or light.

Art Form
Dance

MSCCR Creative Arts Standards
DA: Pr5.1.4 Develop and refine artistic technique and work for presentation. EMBODY
a. Demonstrate fundamental dance skills (for example, alignment, coordination, balance, core support, kinesthetic awareness) and movement qualities when replicating and recalling patterns and sequences of locomotor and non-locomotor movements

Enduring Understanding:
Dancers use the mind-body connection and develop the body as an instrument for artistry and artistic expression.

Essential Questions:
What must a dancer do to prepare the mind and body for artistic expression?

Duration
30-45 minutes

Materials
How to Make a Lemon Battery Lesson (link below)
The Elements of Dance Poster
Space to move

Notebook
Pencils
Batteries
Lemons
Copper & Zinc electrodes
Wires with alligator connector clips
Voltmeters or multimeters
A lemon, or other citrus fruit
18 (or smaller) gauge copper wire
Wire stripper/clipper
Steel paper clip, small galvanized nail (one that is covered in zinc), or a piece of zinc (ideal)

Objectives
Students will create a battery out of a lemon.
Students will use their bodies to show what is going on with the electrons to produce the power and voltage through a movement performance.

Vocabulary
Voltage
Battery
Current
Weight
Movement
Resistance

Dance Vocabulary
Movement
Performance
Space
Time
Tempo
Flow
Level

Lesson Description

1. TTW say, “As different forms of energy, heat, and electricity can be produced in different ways and are transferred and conducted from one form or object to another. Some materials can be conductors or insulators of heat energy. Electricity can be transferred from place to place by electric currents to produce motion, sound, heat, or light.”

2. TTW ask the students to close their eyes and envision moving to the music. TTW play music that has three distinctly different sounds. TTW ask the students to raise their hands, and one by one describe each clip of music.

3. TTW ask, *What must a dancer do to prepare the mind and body for artistic expression?*

4. Next, TTW ask the students to stand and begin moving to the clips of music (again, fast, slow, smooth, choppy, various cultures) as they did in their heads earlier. Then, ask students to move to each selection again, thinking about the levels they are moving in space (high, medium, low) and the flow of their movements.

5. TTW ask students what it felt-like or looked-like the second time they moved to the music.

6. Then, TTW share *The Elements of Dance* poster with the students and focus on the following elements: Space: Level, Time: Tempo, Energy: Weight, and Energy: Flow.

7. TTW give students the opportunity to demonstrate some movements that might be appropriate for each of these elements.

8. Whole Group Instruction: TTW ask, “Has your flashlight ever stopped working because the batteries were dead? It’s no fun walking around in complete darkness. Batteries are everywhere—in our toys, in our cars, in our flashlights, and cell phones. But how do they work? What makes them stop working? You can learn how to make a lemon battery to learn more about these very important devices.”
    a. TTW use the wire strippers to first strip about 2 1/2 inches of plastic insulation off the copper wire. Then:

    b. TTW carefully straighten the steel paper clip. Use the wire clippers to cut it to the same length as your copper wire.

    c. TTW use the sandpaper to rub out any rough spots in your wire or paperclip. You are going to be touching the wire ends to your tongue, so you want them to be smooth. If you are using the zinc covered nail or piece, scratch it lightly with the sandpaper to expose a fresh surface.

    d. TTW Roll the lemon gently on a table to break the cell walls and loosen up the juice inside. The sour juice is needed for the chemical reaction that you are about to start. *The fact that the juice is sour should give us some hints about what kind of chemicals make up lemon juice. What do you think the sour flavor might tell us?*

    e. TTW carefully stick the copper wire about 1 inch into the lemon.

f. TTW request a volunteer and ask the student to make sure his/her tongue is moist with saliva, or spit. TSW touch his/her tongue to the copper wire. *Do you notice anything?* TSW answer *(When you touched your tongue to just the copper wire, you most likely would not have noticed anything unusual. When you touched your tongue to BOTH of the metal ends, you might have felt a tingle, or noticed a metallic taste.)*

g. TTW stick the paperclip, zinc covered nail or zinc strip into a spot in the lemon about 1/4 inch away from the copper wire. TTW make sure the wires don't touch. The wires need to be close to each other because they will be swapping matter in the chemical reaction. If they are too far apart, the matter might lose their way.

h. TTW ask, "Students, why do you think this has happened?" (Answers will vary/The teacher may need to interpret: The tingle or metal taste you noticed shows that your lemon battery was generating an electric current. That means tiny electrons were moving across the surface of your tongue. Electrons are subatomic particles that zoom around an atom's center and make up the part of the atom that is negatively charged. *The lemon battery you made is a type of battery called a voltaic battery. These types of batteries are made of two different metals, which act as electrodes, or places where electrons can enter or leave a battery. In your case, the electrical current entered your tongue, which is why you felt a tingle).

i. TTW ask, "So why were we able to stick electrodes into a lemon and get a battery?" TSW respond, though answers will vary (All voltaic batteries need their metals to be placed in an electrolyte. An electrolyte is a substance that can carry electrical current when dissolved in water. The tiny bit of salt in your saliva makes your saliva an electrolyte, and the sour citric acid does the same thing for lemon juice. Batteries stop working when there is not enough of the electrolyte to react with the metal or not enough metal left to react with the electrolyte).

9. Small-Group Instruction - Activity 1: TSW examine the terms Voltage, Current, and Resistance from the lesson and utilize *The Elements of Dance* in order to determine which element could be used to show Voltage (Space: Level)?
    a. Which element could be used to show Current (Energy: Flow)?
    b. Which element could be used to show Resistance (Energy: Weight)?
    c. TSW create a movement sentence and justify those movements for the teacher as he/she rotates and observes students working within the room.

10. Small-Group Instruction - Activity 2: TSW look at the equation engineers use to determine voltage (Current x Resistance = Voltage).
    a. TSW try moving to this equation using the appropriate dance elements (Flow x Weight = Level).

b. TSW do the same for Power (Current x Voltage = Power) = (Flow x Level = Movement).
c. TSW create a movement sentence and justify those movements for the teacher as he/she rotates and observes students working within the room.

11. Small-Group Instruction - Activity 3: TSW explore different levels of voltage and power in small group performances.
    a. TTW divide students into groups of 4-5 and assign them a battery level (low, mid, high-voltage).
    b. TTW then, ask each group to create a movement performance using the elements of dance to show both the battery's voltage and power.
    c. TSW use 2 cellos "Thunderstruck": https://youtu.be/uT3SBzmDxGk to create their dances that demonstrate voltage and power.
    d. TTW set a timer that projects on the board, so the students know how much time they have to choreograph their dance.
    e. TTW remind students about how they can be good performers and how they can be good audience members.
    f. Allow the rest of the class/audience to provide feedback on each performance.
        i. "I noticed…"
        ii. I like the way...because…"
        iii. Have you thought of…?"
        iv. I would like to suggest…"

12. Closure:
    a. TTW ask, "*What must a dancer do to prepare the mind and body for artistic expression?*
    TSW respond.

    b. TTW ask, "How can heat and electrical energy be transformed into other forms of energy?"
    TSW respond.

    c. TTW ask, "How can an electric current exist in a complete, simple circuit?"
    TSW respond.

Recommended Resources
https://www.education.com/science-fair/article/lemon-power/

Extended Learning

You can generate more electrical current by connecting multiple lemon batteries. Just make a second battery and connect the zinc or steel piece of one battery with the copper wire of the other battery using another piece of copper wire to act as a bridge.

You can use your enlarged lemon battery to power a low-power device like a digital watch or calculator. Remove the regular battery from the digital watch or calculator. Then, hook up the copper electrode of your lemon battery with the battery slot's positive contact. Connect the zinc or iron electrode with the negative contact. Can you get the device to work?

If you are looking to test a variable, try making batteries using different fruits and vegetables. Which ones produce the biggest tingle on your tongue? Which ones generate the most electric current?

Assessment Strategies:

One Minute Question	**-**	**"**Students, you will have one minute to write a response to a focused question with a specific goal that can, in fact, be answered within one minute. *What do you know about energy, heat, and electricity?"*
Peer Assessment	-	Allow peers to ass one another by promoting focus and attention on clear criteria, listening skills, observations, and communication skills. Encourage students to use sentence starters like, "I noticed…", "I like the way you…, because..", "Have you ever thought off….?", or "I would like to suggest…"
Journals	-	Write a personal response following the dance experience.
3-2-1 Strategy	-	The students will 3 things they discovered, 2 interesting things they noticed, and 1 question they still have.

Author

Cristi Clark adapted from educationcloset.com